Notice No.2

Rules and Regulations for the Classification of Naval Ships, January 2021

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

Issue date: June 2021

Amendments to	Effective date	IACS/IMO implementation (if applicable)
Volume 2, Part 1, Chapter 3, Section 17	1 July 2021	1 July 2021
Volume 2, Part 3, Chapter 2, Section 4	1 July 2021	1 July 2021
Volume 2, Part 4, Chapter 2, Section 3	1 July 2021	1 July 2021
Volume 2, Part 4, Chapter 3, Sections 1 & 4	1 July 2021	1 July 2021
Volume 2, Part 4, Chapter 4, Section 5	1 July 2021	1 July 2021
Volume 2, Part 6, Chapter 1, Sections 1 & 4	1 July 2021	1 July 2021
Volume 2, Part 7, Chapter 1, Sections 2, 11 & 17	1 July 2021	N/A
Volume 2, Part 7, Chapter 2, Section 9	1 July 2021	N/A
Volume 2, Part 7, Chapter 3, Sections 3 & 4	1 July 2021	N/A
Volume 2, Part 7, Chapter 5, Sections 7, 8, 9 & 10	1 July 2021	N/A
Volume 2, Part 9, Chapter 3, Section 6	1 July 2021	1 July 2021
Volume 2, Part 9, Chapter 3, Section 7	1 July 2021	N/A
Volume 2, Part 11, Chapter 1, Section 3	1 July 2021	N/A
Volume 2, Part 11, Chapter 2, Sections 1, 2 & 4	1 July 2021	N/A
Volume 2, Part 11, Chapter 4 (New)	1 July 2021	N/A

Lloyd's Register

Volume 2, Part 1,
Chapter 3
Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

■ *Section 17*
Sea trials

17.3 Performance testing requirements for naval vessels

(Part only shown)

17.3.8 The following information is to be available on board for the use of designated personnel:

- For ships having multiple propellers or multiple steering-propulsion arrangements, the results of trials to determine the ability to navigate and manoeuvre with one or more propellers or steering-propulsion units inoperative;

Volume 2, Part 3,
Chapter 2
Shafting Systems

■ *Section 4*
Design and construction

4.16 Sternbushes and sterntube arrangements

4.16.2 The length of the bearing in the sternbush next to and supporting the propeller is to be as follows:

(a) For water lubricated bearings which are lined with lignum vitae, rubber composition or staves of ~~approved plastics~~ synthetic material, the length is to be not less than ~~four~~ 4,0 times the rule diameter ~~required for~~ of the ~~screw~~shaft ~~under~~ in way of the ~~liner~~ bearing.

(b) For water lubricated bearings lined with two or more circumferentially spaced sectors, of ~~an approved plastics~~ synthetic material, without axial grooves in the lower half, the length of the bearing is to be such that the nominal bearing pressure will not exceed 0,55 ~~N/mm^2~~ MPa. The length of the bearing is to be not less than ~~twice its~~ 2,0 times the rule diameter of the shaft in way of the bearing.

(c) For oil lubricated bearings of synthetic material ~~the flow of lubricant is to be such that overheating, under normal operating conditions, cannot occur. The acceptable nominal bearing pressure will be considered upon application and is to be supported by the results of an agreed test programme.~~, the length of the bearing is, in general, to be not less than 2,0 times the rule diameter of the shaft in way of the bearing. The nominal bearing pressure is not to exceed the maximum for which the synthetic material has been approved.

(d) For bearings which are white-metal lined, oil lubricated and provided with an approved type of oil sealing gland, the length of the bearing is to be approximately ~~twice~~ 2,0 times the rule diameter ~~required for the screwshaft~~ of the shaft in way of the bearing and is to be such that the nominal bearing pressure will not exceed 0,8 ~~N/mm^2~~ MPa. The length of the bearing is to be not less than 1,5 times its diameter.

(e) For bearings of cast iron and bronze which are oil lubricated and fitted with an approved oil sealing gland, the length of the bearing is, in general, to be not less than ~~four~~ 4,0 times the rule diameter ~~required for the screwshaft~~ of the shaft in way of the bearing.

(f) ~~Oil lubricated non-metallic bearings are to be manufactured from an approved material. The length of the bearing is to be such that the maximum approved bearing pressure is not exceeded for any limiting length to diameter ratio.~~ For bearings which are grease lubricated, the length of the bearing is to be not less than 4,0 times the rule diameter of the shaft in way of the bearing. Other lengths may be considered upon application, subject to the provision of suitable supporting in-service or testing evidence at relevant shaft pressures and velocities.

4.16.3 Synthetic materials for application as ~~water lubricated~~ stern tube bearings are to be approved in accordance with *Rules for the Manufacture, Testing and Certification of Materials*, *Ch 14, 2.13 Sterntube bearings ~~2.13.1~~*.

4.16.5 Forced water lubrication is to be provided for all bearings lined with rubber or ~~plastics~~ synthetic material. The supply of water may come from a circulating pump or other pressure source. Flow indicators are to be provided for the water service to ~~plastics and rubber~~ the bearings. The water grooves in the bearings are to be of ample section and of a shape which will be little affected by weardown, particularly for bearings of ~~the plastics type~~ synthetic material.

4.16.10 For oil lubricated bearings of synthetic material, the flow of lubricant is to be such that overheating, under normal operating conditions, cannot occur.

Existing paragraphs 4.16.10 to 4.16.12 have been renumbered 4.16.11 to 4.16.13.

Volume 2, Part 4,
Chapter 2
Water Jet Systems

■ *Section 3*
Design requirements

3.7 Nozzle/steering systems

3.7.3 The main steering gear is to be:

(a) Of adequate strength and capable of changing direction of the ship's steerable water jet from one side to the other in accordance with the declared steering angle limits at an average ~~rotational~~ turning speed of not less than 2,3 deg/s with the ship running ahead at maximum ahead service speed which shall be demonstrated in accordance with *Vol 2, Pt 1, Ch 3, 13.3 Testing*, *Vol 2, Pt 1, Ch 3, 17.3 Performance testing requirements for naval vessels* and *Vol 2, Pt 4, Ch 2, 7.3 Sea trial requirement*; and

(b) Operated by power; and

(c) So designed that they will not be damaged at maximum astern speed; this design requirement need not be proved by trials at maximum astern speed and declared steering angle limits.

(Part only shown)

3.7.4 The auxiliary steering gear is to be:

(b) Of adequate strength and capable of changing the direction of the ship's water jet nozzles from one side to the other in accordance with the declared steering angle limits at an average ~~rotational~~ turning speed of not less than 0,5 deg/s, with the ship running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater; and

3.7.5 In addition to the requirements in *Vol 2, Pt 4, Ch 2, 2.1 Water jet arrangement 2.1.1*, for ships fitted with a single steerable water jet, where the main steering gear comprises two or more identical power units and two or more identical steering actuators, auxiliary steering gear need not be fitted provided that the steering gear:

(a) Is capable of satisfying the requirements in *Vol 2, Pt 4, Ch 2, 3.7 Nozzle/steering systems 3.7.3 (a)* while any one of the power units is out of operation; and

(b) Is arranged so that after a single failure in its piping system or in one of the power units, steering capability can be maintained or speedily regained.

Existing paragraph 3.7.5 has been renumbered 3.7.6 and amended as below;

3.7.6 For ships fitted with more than one steerable water jet, where each main steering system comprises two or more identical steering actuating systems, auxiliary steering gear need not be fitted provided that each steering gear:

(a) Is capable of satisfying the requirements in *Vol 2, Pt 4, Ch 2, 3.7 Nozzle/steering systems 3.7.3 (a)* while any one of the power units is out of operation; and

(b) Is arranged so that after a single failure in its piping or in one of the steering actuating systems, steering capability can be maintained or speedily regained (e.g. by the possibility of positioning the failed steering system in a neutral position in an emergency, if needed). Consideration will be given to alternative arrangements providing equivalence can be demonstrated.

The above capacity requirements apply regardless of whether the steering systems are arranged with shared or dedicated power units.

Existing paragraphs 3.7.6 to 3.7.9 have been renumbered 3.7.7 to 3.7.10.

Volume 2, Part 4, Chapter 3
Thrusters

■ *Section 1*
General requirements

1.2 Redundancy

1.2.1 In general, for a ship to be assigned an unrestricted service notation, ~~A~~ a minimum of two azimuth thruster units is to be provided where these form the sole means of propulsion. ~~Where~~ For ships where a single azimuth thruster installation is proposed as the sole means of propulsion or steering, a detailed engineering and safety justification is to be evaluated by LR. This evaluation process will include a risk assessment analysis using a recognised technique to verify that sufficient levels of redundancy and monitoring are incorporated in the azimuth thruster's essential support systems and operating equipment. ~~it will be subject to consideration.~~ The risk assessment is to take ~~taking~~ into account the proposed restricted area notation.

■ *Section 4*
Design and construction

4.2 Azimuth thrusters

4.2.3 The main steering gear is to be:

(a) Of adequate strength and capable of changing direction of the ship's azimuth thruster from one side to the other in accordance with the declared steering angle limits at an average ~~rotational~~ turning speed of not less than 2,3 deg/s with the ship running ahead at maximum ahead service speed which shall be demonstrated in accordance with *Vol 2, Pt 1, Ch 3, 14.2 Azimuth thrusters* and *Vol 2, Pt 1, Ch 3, 17.3 Performance testing requirements for naval vessels*; and

(b) Operated by power; and

(c) So designed that they will not be damaged at maximum astern speed; this design requirement need not be proved by trials at maximum astern speed and declared steering angle limits.

(Part only shown)

4.2.4 The auxiliary steering gear is to be:

(b) Of adequate strength and capable of changing the direction of the ship's azimuth thrusters from one side to the other in accordance with the declared steering angle limits at an average ~~rotational~~ turning speed of not less than 0,5 deg/s with the ship running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater; and

4.2.5 In addition to the requirements in *Vol 2, Pt 4, Ch 3, 1.2 Redundancy 1.2.1*, for ships fitted with a single azimuth thruster, where the main steering gear comprises two or more identical power units and two or more identical steering actuators, auxiliary steering gear need not be fitted provided that the steering gear:

(a) Is capable of satisfying the requirements in *Vol 2, Pt 4, Ch 3, 4.2 Azimuth thrusters 4.2.3 (a)* while any one of the power units is out of operation; and

(b) Is arranged so that after a single failure in its piping system or in one of the power units, steering capability can be maintained or speedily regained.

Existing paragraph 4.2.5 has been renumbered 4.2.6 and amended as below;

4.2.6 For ships fitted with more than one azimuth thruster, where each main steering system comprises two or more identical steering actuating systems, auxiliary steering gear need not be fitted provided that each steering gear:

(a) Is capable of satisfying the requirements in *Vol 2, Pt 4, Ch 3, 4.2 Azimuth thrusters 4.2.3 (a)* while any one of the power units is out of operation; and

(b) Is arranged so that after a single failure in its piping or in one of the steering actuating systems, steering capability can be maintained or speedily regained (e.g. by the possibility of positioning the failed steering system in a neutral position in an emergency, if needed). Consideration will be given to alternative arrangements providing equivalence can be demonstrated.

The above capacity requirements apply regardless of whether the steering systems are arranged with shared or dedicated power units.

Existing paragraphs 4.2.6 to 4.2.9 have been renumbered 4.2.7 to 4.2.10.

Volume 2, Part 4, Chapter 4 Podded Propulsion Units

■ *Section 5*
Machinery design and construction requirements

5.6 Steering system

5.6.4 The main steering gear is to be:

(a) Of adequate strength and capable of changing direction of the podded propulsion unit from one side to the other in accordance with the declared steering angle limits at an average ~~rotational~~ turning speed of not less than 2,3 deg/s with the ship running ahead at maximum ahead service speed which shall be demonstrated in accordance with *Vol 2, Pt 1, Ch 3, 15.2 Testing and trials* and *Vol 2, Pt 1, Ch 3, 17.3 Performance testing requirements for naval vessels*; and

(b) Operated by power; and

(c) So designed that they will not be damaged at maximum astern speed; this design requirement need not be proved by trials at maximum astern speed and declared steering angle limits.

(Part only shown)

5.6.5 The auxiliary steering gear is to be:

(b) Of adequate strength and capable of changing the direction of the ship's podded propulsion units from one side to the other at in accordance with the declared steering angle limits at an average ~~rotational~~ turning speed of not less than 0,5 deg/s, with the ship running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater; and

5.6.6 In addition to the requirements in *Vol 2, Pt 4, Ch 4, 2.1 Pod arrangement 2.1.1*, for ships fitted with a single podded propulsion unit, where the main steering gear comprises two or more identical power units and two or more identical steering actuators, auxiliary steering gear need not be fitted provided that the steering gear:

(a) Is capable of satisfying the requirements in *Vol 2, Pt 4, Ch 4, 5.6 Steering system 5.6.4 (a)* while any one of the power units is out of operation; and

(b) Is arranged so that after a single failure in its piping system or in one of the power units, steering capability can be maintained or speedily regained.

Existing paragraph 5.6.6 has been renumbered 5.6.7 and amended as below;

5.6.7 For ships fitted with more than one podded propulsion unit, where each main steering system comprises two or more identical steering actuating systems, auxiliary steering gear need not be fitted provided that each steering gear:

(a) Is capable of satisfying the requirements of *Vol 2, Pt 4, Ch 4, 5.6 Steering system 5.6.4 (a)* while any one of the power units is out of operation; and

(b) Is arranged so that after a single failure in its piping or in one of the steering actuating systems, steering capability can be maintained or speedily regained (e.g. by the possibility of positioning the failed steering system in a neutral position in an emergency, if needed). Consideration will be given to alternative arrangements providing equivalence can be demonstrated.

The above capacity requirements apply regardless of whether the steering systems are arranged with shared or dedicated power units.

~~5.6.7~~ 5.6.8 The steering gear for podded units used for dynamic positioning applications with an associated class notation, is to be capable of a ~~rotational~~ turning speed of not less than 9 deg/s.

Existing paragraphs 5.6.8 to 5.6.11 have been renumbered 5.6.9 to 5.6.12.

Volume 2, Part 6, Chapter 1 Steering Gear

■ *Section 1* General requirements

1.2 Definitions

1.2.10 **Declared steering angle limits** are the operational limits in terms of maximum steering angle, or equivalent, according to manufacturer's guidelines for safe operation, also taking into account the ~~vessel~~ ship's speed or propeller torque/speed or other limitation; ship's manoeuvring characteristics required by **LMA** or **LMNA** notations are to be carried out with steering angles not exceeding the declared steering angle limits.

■ *Section 4* Performance

4.1 General

4.1.2 Unless the main steering arrangements for ship directional control comprise two or more identical power units, in accordance with *Vol 2, Pt 6, Ch 1, 4.2 Performance requirements for rudder-type steering systems 4.2.1*, every ship is to be provided with main steering arrangements and auxiliary steering arrangements, or two or more identical steering actuating systems, in accordance with the requirements of the Rules. The main and auxiliary steering arrangements are to be so arranged that the failure of one of them will not render the other one inoperative.

Volume 2, Part 7,
Chapter 1
Piping Design Requirements

■ *Section 2*
General

2.1 Documentation required for design review

2.1.3 Pipe flow calculations are to be submitted for all mobility and ship type piping systems, together with validation reports as appropriate for the calculation method. The responsibility for error free specification and input of program data and the subsequent correct transposition of output rests with the designer.

■ *Section 11*
Plastic pipes

11.6 Additional fire performance criteria applicable to naval vessels

(Part only shown)

Table 1.11.1 Fire endurance requirements

Piping systems	Location									
	A	B	C	D	E	F	G	H	I	J
SEA WATER[1]										
8 Foam system	L1W	L1W	N/A	N/A	N/A	N/A	N/A	0	L1W	L1W
9 Sprinkler system	L1W	L1W	X	N/A	N/A	N/A	0	0	L3	L3
11 Cooling water, Mobility and/or Ship Type systems	L3	L3	N/A	N/A	N/A	N/A	0	0	N/A	L2W
SANITARY/DRAINS/SCUPPERS										
16 Deck drains (internal)	~~L1~~[4] L1W[4]	~~L1~~[4] L1W[4]	~~L1~~[4] L1W[4]	0	N/A	0	0	0	0	0
MISCELLANEOUS										
24 Auxiliary low pressure steam (≤ 0,7 MPa)	L2W	L2W	0[7]	0[7]	0	0	0	0	0[7]	0[7]
NEW SERVICES										
25 Central vacuum cleaners	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A	0	0
26 Exhaust gas cleaning system effluent line	L3[1]	L3[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L3[1,9]/N/A
27 Urea transfer/supply system (SCR installations)	L1[10]	L1[10]	N/A	N/A	N/A	N/A	N/A	N/A	0	L3[1,9]/N/A
LOCATION DEFINITIONS										

E	~~f.p. ≤ 60 pC tanks~~ f.p. ≤ 60 pc °C tanks	All spaces used for refuelling fuel and trunks to such spaces
ABBREVIATIONS		
L1	~~Fire endurance test in dry conditions, 60 minutes, *IMO Resolution A.753(18) - Guidelines for the Application of Plastic Pipes on Ships - (adopted on 4 November 1993) Amended by Resolution MSC.313(88) Appendix 1 - Test Method for Fire Endurance Testing of Plastic Piping in the Dry Condition.*~~ Level 1. Piping having passed the fire endurance test specified in Appendix 1 of *IMO Resolution A.753(18)*, as amended by *IMO Resolution MSC. 313(88)* and *IMO Resolution MSC.399(95)* for a duration of a minimum of one hour without loss of integrity in the dry condition is considered to meet level 1 fire endurance standard (L1). Level 1W – Piping systems similar to Level 1 systems except these systems do not carry flammable fluid or any gas and a maximum 5% flow loss in the system after exposure is acceptable (L1W).	
L2	~~Fire endurance test in dry conditions, 30 minutes, *IMO Resolution A.753(18) - Guidelines for the Application of Plastic Pipes on Ships - (adopted on 4 November 1993) Amended by Resolution MSC.313(88) Appendix 1 - Test Method for Fire Endurance Testing of Plastic Piping in the Dry Condition.*~~ Level 2. Piping having passed the fire endurance test specified in Appendix 1 of *IMO Resolution A.753(18)*, as amended by IMO Res. MSC. 313(88) and IMO Res. MSC.399(95) for a duration of a minimum of 30 minutes in the dry condition is considered to meet level 2 fire endurance standard (L2). Level 2W – Piping systems similar to Level 2 systems except a maximum 5% flow loss in the system after exposure is acceptable (L2W).	
NOTES		
Note *9.* L3 in service spaces, N/A in accommodation and control spaces. **Note** *10.* Type Approved plastic piping without fire endurance test (0) is acceptable downstream of the tank valve, provided this valve is metal seated and arranged as fail-to-closed or with quick closing from a safe position outside the space in the event of fire.		

■ *Section 17*
Guidance notes on metal pipes for water service

17.2 Materials

17.2.3 Consideration is to be given to avoiding the formation of a galvanic couple where an electrical component in the piping system is connected to the ship's earth.

Volume 2, Part 7, Chapter 2 Ship Piping Systems

■ *Section 9*
Additional requirements relating to fixed pressure water spray fire-extinguishing systems

9.1 Bilge drainage requirements

9.1.1 Systems are to be designed in accordance with the requirements of an appropriate international or naval standard.

9.1.2 Documentation is to be submitted in accordance with *Vol 2, Pt 7, Ch 1, 2.1 Documentation required for design review*, including a system design description and pipe flow calculations.

Existing paragraphs 9.1.1 to 9.1.4 have been renumbered 9.1.3 to 9.1.6.

Volume 2, Part 7,
Chapter 3
Machinery Piping Systems

■ *Section 3*
Fuel oil burning arrangements

3.9 Fuel oil treatment for supply to engines and gas turbines

3.9.1 ~~Suitable~~ Where required for the operation of the engines or gas turbines, a suitable fuel treatment plant that may include filtration, centrifuging and/or coalescing is to be provided to reduce the level of water and particulate contamination of the fuel oil to within the engine or gas turbine manufacturer's limits for inlet to the combustion system. The capacity and arrangements of the treatment plant is to be suitable for ensuring availability of treated fuel oil for the maximum continuous rating of the propulsion and electrical generating plant.

■ *Section 4*
Fuel oil pumps, pipes, fittings, tanks, etc.

4.9 Water drainage

~~4.9.1 All fuel oil storage, settling and service tanks are to be provided with a means of removing water from the lowest point in the tank.~~

4.9.1 Settling tanks and service tanks are to be provided with means for removing water from the lowest point in the tank.

4.9.2 If settling tanks and service tanks are not provided, the fuel oil storage tanks are to be fitted with means for removing water from the lowest point in the tank.

4.9.3 Open drains for removing the water from oil tanks are to be fitted with valves or cocks of a self-closing type, and suitable provision is to be made for collecting the oily discharge.

Volume 2, Part 7,
Chapter 5
Ship Type Piping Systems

■ *Section 7*
Chilled water systems

7.1 General

7.1.4 The demineralised water used in chilled water distribution systems is to be in accordance with the system designer's specification ~~that typically would include the following limitations:~~ .

~~• Conductivity: <4,5 micromhs/cm^3~~
~~• Dissolved solids: Zero~~
~~• Alkalinity: pH 7,1~~
~~• Suspended solids: <2,5 ppm with particle size~~
~~<250 microns~~

~~The specification for demineralised water is to be agreed by the Owner.~~

7.2 Refrigeration plant

7.2.2 The refrigeration plants are to be located in separate compartments and zones such that the loss of one compartment or zone, or failure in equipment will not render the other refrigeration plant(s) inoperative. In NS3 category ships the requirement for ~~pumps~~ plants to be located in separate zones will not be insisted on where agreed by the Owner and included in the System Design Description.

7.2.3 The refrigeration systems and compartments containing the refrigeration plants are to comply with the requirements in *Vol 2, Pt 11, Ch 4 Refrigeration System Arrangements*, and are to be provided with refrigerant gas detectors in accordance with *Vol 2, Pt 9, Ch 11 Gas Detection* with audible and visual alarms.

Existing paragraphs 7.2.4 to 7.2.6 have been moved to Vol2, Pt 11, Ch4. 3.1.1 to 3.1.3.

Existing paragraph 7.2.7 has been deleted.

Existing paragraphs 7.2.8 to 7.2.10 have been moved to Vol, 2 Pt, 11, Ch4. 3.1.6 to 3.1.8.

■ *Section 8*
High pressure compressed air systems

8.4 Distribution system

8.4.3 Reducing valves/stations for users of reduced pressure air are to be provided throughout the ship. Pipelines that are situated on the low pressure side of reducing valves/stations, and that are not designed to withstand the full pressure of the source supply, are to be provided with pressure gauges and with relief valves having sufficient capacity to protect the piping against excessive pressure. Inline filters are to be fitted at each reducing valve/station on the ~~reduced~~ high pressure side.

■ *Section 9*
Low pressure compressed air systems

9.4 Distribution system

9.4.3 Reducing valves/stations for users of reduced pressure air are to be provided throughout the ship. Pipelines that are situated on the low pressure side of reducing valves/stations, and that are not designed to withstand the full pressure of the source supply, are to be provided with pressure gauges and with relief valves having sufficient capacity to protect the piping against excessive pressure. In-line filters are to be fitted at each reducing valve/station on the ~~reduced~~ high pressure side.

■ *Section 10*
High pressure sea-water systems

10.2 Pump units

10.2.3 The total pumping capacity of the HPSW pumps with one pump out of action shall provide for the greatest of the following:

(a) The amount required for pre-wetting.

(b) The amount required for a fire in the largest ~~machinery~~ space ~~using the largest~~ protected by a fixed spray system plus 40 m^3/hr boundary cooling from hoses.

(c) The amount required for a major fire outside the ~~machinery~~ spaces protected by fixed spray systems, using 100 m^3/hr boundary cooling for each fire. The minimum number of fires to be considered is as follows:

  i. Displacement at design draught of under 4,000 tonnes – one fire
  ii. Between 4,000 and 10,000 tonnes – two fires
  iii. Between 10,000 and 20,000 tonnes – three fires
  iv. Over 20,000 tonnes – four fires

Reference is also to be made to the System Design Description required by *Vol 2, Pt 7, Ch 5, 1.3 Documentation required for design review 1.3.2* where the number of fires to be considered may also reference amongst other items, the type of ship, number of personnel on board and number of fire zones.

(d) The largest single magazine or ammunition transfer space spray requirement plus 40 m^3/hr boundary cooling.

(e) The hangar spray requirement in the largest area contained by a fire curtain.

(f) A flight deck fire requiring one third of the total foam branch pipes fitted in multi-aircraft landing (multi-spot) ships or two foam branch pipes in single aircraft landing (single spot) ships.

(g) The amount required for any specific fire-fighting scenarios defined by the System Design Description.

If the factor determining the total pumping capacity is (b), then any pumps located in the space are to be added to the overall number of pumps required

Volume 2, Part 9,
Chapter 3,
Electrical Power Distribution and Equipment

■ *Section 6*
Rotating machines – general requirements and motors

6.1 General requirements

6.1.23 The entity responsible for assembling the alternating current generating set is to install a rating plate marked with at least the following information:

(a) the generating set manufacturer's name or mark;
(b) the set serial number;
(c) the set date of manufacture (month/year);
(d) the rated power (both in kW and kVA) with one of the power rating prefixes COP, PRP (or, only for emergency generating sets, LTP) as defined in ISO 8528-1 *Reciprocating internal combustion engine driven alternating current generating sets*;
(e) the rated power factor;
(f) the set rated frequency (Hz);
(g) the set rated voltage (V);
(h) the set rated current (A); and
(i) the mass (kg).

■ *Section 7*
Converter equipment

7.3 Uninterruptible power systems

7.3.14 UPS units utilising lithium battery systems as energy storage devices are to be in accordance with the following sub-Sections of these Rules as applicable and to the recommendations of the battery manufacturer:

- *Vol 2, Pt 9, Ch 1, 1.4 Documentation required for design review*;
- *Vol 2, Pt 9, Ch 2, 7.1 General requirements*;
- *Vol 2, Pt 9, Ch 2, 7.2 Design and construction*;
- *Vol 2, Pt 9, Ch 2, 7.3 Location*;
- *Vol 2, Pt 9, Ch 2, 7.4 Installation*;
- *Vol 2, Pt 9, Ch 2, 7.5 Thermal management and ventilation*; and
- *Vol 2, Pt 9, Ch 12, 21.1 Testing*.

Volume 2, Part 11,
Chapter 1
Made and Fresh Water Systems

■ *Section 3*
System arrangements

3.1 Water storage facilities

3.1.2 At least two storage tanks are to be fitted, each with separate means of supplying the fresh water distribution main. ~~The~~ In NS1 and NS2 type ships these tanks are ~~to be spatially separated~~ not to share a common boundary or be directly cross-connected and ~~in NS1 and NS2 type ships~~ at least one of the tanks is to be sited other than in the double bottom space. The tanks are to be sited and be of such dimensions that they are readily accessible to facilitate inspection, cleaning and coating.

3.2 Made water production facilities

3.2.1 Made water production facilities fitted are to be capable of producing water to World Health Organisation Guidelines for Drinking Water Quality, Volume 1 Recommendations Second Edition 1994 as a minimum requirement. A more stringent quality of water production may be necessary in the case of water for use in, for example, boiler feed systems, battery top-up, or gas turbine washing. In these cases, an alternative means of water production is to be provided or a further stage of desalination included in the

production arrangements. Where the specified standards for made water are other than the World Health Organisation Standards, these are to be provided to LR.

3.3 Piping system design

3.3.8 Not less than two sea inlets are to be provided for pumps supplying seawater to the fresh water generating plants. The sea inlets are to be independent ~~of other sea inlets~~ from each other and other ship's services and are to be located forward and clear of any bilge or sanitary discharges.

Volume 2, Part 11,
Chapter 2
Heating, Ventilation and Cooling Arrangements

■ *Section 1*
General requirements

1.3 Documentation required for design review

1.3.3 **Systems**. Plans in diagrammatic form showing air intake/exhaust/distribution arrangements, control systems and safeguards and electrical systems covered by this Chapter. Plans are to show trunk/pipe sizes, air/water flows and terminal locations. The capacities of fans, pumps and heating/cooling/filtration plants are to be included. A sizing calculation summary containing the loads, margins, assumptions and calculation method is to be provided. Capacity tables for different operating conditions for the refrigeration compressors are also to be included.

■ *Section 2*
Construction and installation

2.4 Refrigerant systems for cooling

2.4.1 Where chilled water systems complying with *Vol 2, Pt 7, Ch 5 Ship Type Piping Systems* are not used for cooling ventilation air, independent refrigeration plants are to be provided and designed to be capable of extracting a defined heat load duty when operating at the conditions stated in the System Design Description required by *Vol 2, Pt 11, Ch 2, 1.3 Documentation required for design review 1.3.2.* ~~Independent refrigeration plants are to comply with the requirements of this Chapter.~~

2.4.2 The refrigeration systems and compartments containing the refrigeration plants are to comply with the requirements in *Vol 2, Pt 11, Ch 4 Refrigeration System Arrangements,* and are to be provided with refrigerant gas detectors in accordance with *Vol 2, Pt 9, Ch 11 Gas detection* with audible and visual alarms.

Existing paragraphs 2.4.3 to 2.4.8 have been moved to Vol, 2 Pt, 11, Ch4, 3.1.1 to 3.1.7.

Existing paragraphs 2.4.9 and 2.4.10 have been moved to Vol, 2 Pt, 11, Ch4, 3.1.9 to 3.1.10.

■ *Section 4*
Control and monitoring and electrical power arrangements

4.1 General

Existing paragraphs 4.1.8 to 4.1.11 have been moved to Vol, 2 Pt, 11 Ch, 4, 5.1.7 to 5.1.10.

Existing paragraphs 4.1.12 and 4.1.13 have been renumbered to 4.1.8 and 4.1.9.

Volume 2, Part 11,
Chapter 4
Refrigeration System Arrangements

■ *Section 1*
General Requirements

1.1 General

1.1.1 This Chapter states the requirements for refrigeration system arrangements installed in naval ships.

1.1.2 The requirements in this Chapter cover the arrangements, equipment, piping and control systems necessary for refrigeration system arrangements on board a naval ship.

1.2 Scope

1.2.1 The refrigeration system arrangements in this Chapter cover the following:
- Refrigeration machinery for distributed chilled water systems.
- Refrigeration machinery for ventilation cooling.
- Refrigeration machinery for cool and cold storage rooms.
- Domestic type self-contained refrigeration units.

Refrigeration machinery for cool and cold rooms and domestic type self-contained refrigeration units rooms need only comply with *Vol 2, Pt 11, Ch 4, 4 Refrigerant charge limits, machinery room, and storage arrangements* and *Vol 2, Pt 11, Ch 4, 6.1 Testing 6.1.4(a)*, unless the PRM notation has been assigned.

1.2.2 The distributed chilled water system is to comply with *Vol 2, Pt 7, Ch 5, 7 Chilled water systems.*

1.2.3 The air-conditioning and ventilation system is to comply with *Vol 2, Pt 11, Ch 2 Heating, Ventilation and Cooling Arrangements.*

1.2.3 Gas detection systems are to comply with *Vol 2, Pt 9, Ch 11 Gas Detection.*

1.2.4 Ships assigned the PRM notation are to additionally comply with *Vol 3, Pt 1, Ch 2 Provision Refrigeration.*

1.2.5 Ships assigned the ECO RS notation are to additionally comply with *Vol 3, Pt 3, Ch 2, 2.9 Refrigeration systems, RS character.*

1.3 Documentation required for design review

1.3.1 Three copies of the plans and information stated in *Vol 2, Pt 11, Ch 4, 1.3 Documentation required for design review 1.3.2 to 1.3.6* are to be submitted to Lloyd's Register (hereinafter referred to as 'LR') as applicable.

1.3.2 **System Design Description.** A System Design Description of each ship type piping system, *see Vol 2, Pt 1, Ch 3, 3.5 System design description.*

1.3.3 **Systems**. Plans in diagrammatic form showing refrigerant and cooling systems, control systems and safeguards and electrical systems covered by this Chapter. Plans are to show pipe sizes, flows and terminal locations. The capacities of fans and pumps are to be included. Capacity tables for different operating conditions for the refrigeration compressors are also to be included.

1.3.4 **Compartments**. Plans showing the general arrangement of refrigeration plant compartments, together with a description of the equipment and arrangements installed for isolation and distribution of ventilation air and the electrical power supply systems. The plans are to indicate segregation and access arrangements for compartments and associated control rooms/stations.

1.3.5 **Testing and trials procedures**. A schedule of testing and trials to demonstrate that systems are capable of operating as described in *Vol 2, Pt 11, Ch 4, 3 System arrangements* and as required by *Vol 2, Pt 11, Ch 4, 6 Testing and trials.*

1.3.6 **Operating manuals**. Operating manuals are to be provided on board and submitted for information where requested by LR. The manuals are to include the following information:
(a) Particulars and a description of the systems.
(b) Operating instructions for the equipment and systems (including fire isolation aspects).
(c) Maintenance instructions for the installed arrangements.

■ *Section 2*
Construction and installation

2.1 Materials

2.1.1 Materials used in the construction of the refrigerating equipment and associated systems are to be generally manufactured and tested in accordance with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials*.

2.1.2 Where it is proposed to use materials other than those specified in the *Rules for the Manufacture, Testing and Certification of Materials*, details of the chemical compositions, heat treatment and mechanical properties are to be submitted for approval. In such cases the values of the mechanical properties used for deriving the allowable stress are to be subject to agreement with LR.

2.1.3 All materials used in refrigerating equipment and systems are to be suitable for use with the selected refrigerants. This includes joints, sealing materials and lubricants. For example, the following materials and refrigerants are not to be combined:

- Copper with ammonia.
- Magnesium with fluorinated hydrocarbons.
- Zinc with ammonia or fluorinated hydrocarbons.

2.1.4 For ammonia systems, the condensers/evaporators are to be manufactured in titanium or a suitable grade of stainless steel.

■ *Section 3*
System Arrangements

3.1 General

3.1.1 The design of refrigeration systems is to be such that it permits maintenance and repair without unavoidable loss of refrigerant to the atmosphere. To minimise release of ozone-depleting or high global warning potential substances to the atmosphere, refrigerant recovery units are to be provided for evacuation of a system prior to maintenance.

3.1.2 Refrigeration systems are to be designed to prevent discharge of refrigerant to atmosphere; however, relief devices are to be provided to protect the system from overpressure in the event of a fault, or emergency such as fire. Where discharge of refrigerant gas to atmosphere is unavoidable, arrangements are to be made to prevent discharge into ventilation systems.

3.1.3 A pressure relief valve and/or bursting disc is to be fitted between each positive displacement compressor and its gas delivery stop valve, the discharge being led to the suction side of the compressor. The flow capacity of the valve or disc is to exceed the full load compressor capacity on the particular refrigerant at the maximum potential suction pressure. For these internal relief valves, a servo-operated valve will be accepted. Where the motive power for the compressor does not exceed 10 kW, the pressure relief valve and/or bursting disc may be omitted.

3.1.4 Each pressure vessel which may contain liquid refrigerant, and which is capable of being isolated by means of a stop or automatic control or check valve, is to be provided with two pressure relief valves or two bursting discs, or one of each, controlled by a changeover device.

3.1.5 Pressure vessels that are connected by pipework without valves, so that they cannot be isolated from each other, may be regarded as a single pressure vessel for the purpose of *Vol 2, Pt 11, Ch 4, 3.1 General 3.1.4*, provided that the interconnecting pipework does not prevent effective venting of any pressure vessel.

3.1.6 Omission of one of the specified relief devices and changeover device, as required by *Vol 2, Pt 11, Ch 4, 3.1 General 3.1.4*, will be accepted where:

(a) vessels are of less than 300 litres internal gross volume; or
(b) vessels discharge into the low-pressure side by means of a relief valve.

3.1.7 Sections of systems and components that could become full of liquid between closed valves are to be provided with pressure relief devices relieving to a suitable point in the refrigerant circuit.

3.1.8 Where hermetically sealed compressor units or semi-hermetic compressors with the electric motor cooled by the circulating refrigerant are installed, the following arrangements are to be made:

(a) Each refrigeration system containing hermetically sealed compressor units or semi-hermetic compressors is to be independent of other refrigeration systems.
(b) All hermetic motor-compressors are to be fitted with a thermal cut-out device that protects the motor against overheating.
(c) Each refrigerant circuit is to be designed such that debris or contaminants from a motor failure, typically burn out of insulation, is contained and not distributed around the system.

3.1.9 Seawater systems for refrigeration condensers are to be capable of being supplied from not less than two independent seawater supplies. If required by the System Design Description, these supplies are to be located in separate compartments and

zones such that the loss of one zone or compartment will not result in the loss of the seawater supply to the refrigeration condensers.

3.1.10 The capacity of each seawater supply required by *Vol 2, Pt 11, Ch 4, 3.1 General 3.1.9* is to be sufficient for the conditions stated in the System Design Description.

■ *Section 4*
Refrigerant charge limits, machinery room, and storage arrangements

4.1 Refrigerant classification

4.1.1 The design of the system and safety arrangements are to be implemented based on the class of refrigerant selected for use in the system. The refrigerant classification scheme, ISO 817 *Refrigerants — Designation and safety classification*, is to be considered regarding the flammability and toxicity class of the refrigerant. Flammable (Class 2L, 2, and 3) and toxic (Class B) refrigerants are not to be used in systems designed for non-flammable, non-toxic refrigerants.

4.1.2 The 'practical limit' of a refrigerant represents the highest acceptable concentration level of refrigerant in an occupied space which will not result in any impairment of crew (i.e. acute effects) or create a risk of ignition of the refrigerant. Values for the practical limit for different refrigerants are listed in ISO 5149-1 *Refrigerating systems and heat pumps — Safety and environmental requirements*.

4.2 Refrigerating machinery in accommodation spaces

4.2.1 In accommodation spaces the amount of refrigerant charge is to be restricted to the practical limit.

4.2.2 Accommodation spaces containing refrigerating machinery are to be provided with natural or mechanical ventilation and suitable clearance for ventilation is to be retained around the refrigerating machinery.

4.3 Refrigerating machinery in machinery spaces

4.3.1 Machinery spaces containing refrigerating machinery with an aggregate charge greater than the practical limit for the space are to be provided with refrigerant leak detection monitoring and alarm in accordance with *Vol 2, Pt 9, Ch. 11, 4.4 Refrigerant leak detection systems*.

4.3.2 The maximum charge allowed in machinery spaces is limited as described in *Vol 2, Pt 11, Ch 4, 4.4 Charge limits due to flammability* and *Vol 2, Pt 11, Ch 4, 4.5 Charge limits due to toxicity*. Refrigeration machinery and storage vessels exceeding the maximum charge are to be located in a normally unmanned gastight 'refrigeration machinery space' in accordance with *Vol 2, Pt 11, Ch 4, 4.6 Refrigeration machinery space*.

4.4 Charge limits due to flammability

4.4.1 There is no restriction due to flammability on the charge size of flammability Class 1 refrigerants.

4.4.2 Machinery using flammability Class 2L, 2 and 3 refrigerants may be installed in machinery spaces providing the following controls are complied with:

- The total mass of refrigerant in the space is limited to the values listed in *Table 4.4.1 Refrigerant charge limits*.
- A mechanical ventilation system capable of 30 air changes per hour which is separate from ventilation systems serving other compartments is provided. The ventilation system is to be arranged to ensure a good flow of air around the refrigerating machinery. A lower flow may be used in normal operation provided the system can increase the flow in the event of a leak being detected, but is not to be below a minimum of ten air changes per hour.
- The space shall be provided with fire protection equivalent to a category A machinery space.

4.4.3 If the refrigerant has the potential to produce toxic or corrosive products from combustion, these are to be considered in the fire-fighting design and appropriate warning signage provided adjacent to the machinery.

4.5 Charge limits due to toxicity

4.5.1 There is no restriction due to toxicity on the charge size of toxicity class A refrigerants.

4.5.2 Refrigeration machinery and storage vessels containing toxicity class B refrigerants may be installed in machinery spaces providing the total mass of refrigerant is limited to the values listed in *Table 4.4.1 Refrigerant charge limits*.

Table 4.4.1 Refrigerant charge limits

<table>
<tr><th colspan="2">Refrigerant properties</th><th colspan="2">Maximum allowable total refrigerant charge</th></tr>
<tr><th>Toxicity</th><th>Flammability</th><th>Machinery spaces</th><th>Accommodation spaces</th></tr>
<tr><td rowspan="4">A</td><td>1</td><td>No charge restriction</td><td rowspan="7">PL x V</td></tr>
<tr><td>2L</td><td rowspan="3">20% x LFL x V</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td rowspan="4">B</td><td>1</td><td>≤10 kg</td></tr>
<tr><td>2L</td><td rowspan="3">20% x LFL x V
but no greater than 10 kg</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td colspan="4">LFL = Lower flammability limit (kg/m^3)
PL = Practical limit (kg/m^3)
V = volume of compartment (m^3) (see Note 1)</td></tr>
<tr><td colspan="4">Note 1. Permeability of a compartment does not need to be considered for the calculation (permeability = 1) however, large enclosed volumes such as gas turbine acoustic enclosures should be deducted from the total compartment volume.</td></tr>
</table>

4.6 Refrigeration machinery space

4.6.1 A refrigeration machinery space is to be a normally unattended, gastight space.

4.6.2 The compartment access door is to open outwards and is to be fitted with an easily operated opening mechanism to facilitate rapid escape in an emergency.

4.6.3 Where the refrigerating machinery space contains refrigerant of toxicity class B the space is to be fitted with the following features:

- Independent mechanical exhaust ventilation, ensuring at least ten air changes per hour in empty space.
- Natural or mechanical supply ventilation independent of the ventilation of other spaces.
- The ventilation system shall ensure under-pressure inside the refrigerating machinery space.
- Clear signage indicating the potential hazard and warning not to enter when a leak has been detected.
- Where the charge is greater than 50 kg, emergency body shower and eye wash facilities shall be installed locally outside the compartment.

4.6.4 Where the refrigerating machinery space contains refrigerant of flammability Class 2L, 2 or 3 the space is to be fitted with the following features:

- A non-sparking mechanical exhaust ventilation system, with a capacity of at least 30 air changes per hour, which is arranged to avoid areas where gas may accumulate taking into account the density of the vapour and potential ignition sources. The ventilation system shall be separated from those serving other spaces.
- All machinery and electrical equipment within the space is to be of a type suitable for a zone 2 hazardous area in accordance with *Vol 2, Pt 9, Ch 5, 4 Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts*.
- The leak detection is to be set to alarm at gas concentrations above 30 per cent lower flammable limit (LFL).
- All spaces containing these refrigerants, including exhaust vents, are to be indicated on a hazardous area plan as described in *Vol 2, Pt 9, Ch 1, 1 General requirements*.

4.6.5 In addition to the main ventilation system required by *Vol 2, Pt 11, 4.6 Refrigeration machinery space 4.6.3* and *Vol 2, Pt 11, 4.6 Refrigeration machinery space 4.6.4*, each refrigerating machinery space shall be fitted with an independent emergency exhaust ventilation system ensuring:

- 30 air changes per hour – in the case of refrigerating machinery operating on Group 2L, 2 and 3 refrigerants.
- 20 air changes per hour – in the case of refrigerating machinery operating on Group L refrigerants.

4.6.6 If the refrigerant has the potential to produce toxic or corrosive products from combustion these are to be considered in the fire-fighting design and appropriate warning signs provided at the entrance to the space.

4.6.7 The ventilation design is to consider the density of the refrigerant and draw from the appropriate location to ensure good air distribution and effective exhaust from the compartment.

4.6.8 The refrigerating machinery space shall have two means of escape arranged as far apart as practicable. Spaces with automated unattended refrigerating machinery, operating on Group A1 and B1 refrigerants, need not be provided with a second means of escape.

4.6.9 The starting and stopping arrangements for the ventilation shall be arranged both inside the refrigerating machinery space and outside, in the vicinity of the exit.

4.6.10 Drain pipes from the refrigerated machinery space are to be fitted with liquid sealed traps. Non-return valves are to be fitted in drain pipes from spaces located on the tank tops.

4.7 Refrigerant storage compartments

4.7.1 Portable cylinders containing reserve supplies of refrigerant are to be stored in the same compartment as the refrigeration machinery and included within the charge limit, or in a well-ventilated compartment reserved solely for this purpose.

4.7.2 Compartments for storage of toxic (Class B) or flammable (Class 2L, 2 or 3) refrigerants are to include the following features:

- A mechanical ventilation system providing ten air changes per hour.
- At least one door opening outwards giving direct access to open deck.
- Clear signage indicating the potential hazard and warning not to enter when a leak has been detected.
- Liquid sealed traps fitted to drain pipes. Non-return valves are to be fitted in drain pipes from spaces located on the tank tops.

4.7.3 In addition, all machinery and electrical equipment within compartments for storage of flammable (Class 2L, 2 or 3) refrigerants is to be of a type suitable for a zone 2 hazardous area in accordance with *Vol 2, Pt 9, Ch 5, 4 Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts*.

4.7.4 Bulk storage tanks holding more than 150 kg of replacement carbon dioxide (class A1) are to be located in a dedicated compartment. The compartment is to be provided with the following features:

- A mechanical ventilation system providing ten air changes per hour.
- Ventilation system exhaust ducting positioned to remove air from the base of the compartment.
- A gastight access door opening outward.

4.7.5 The compartment is to be provided with a refrigerant detection system in accordance with *Vol 2, Pt 11, Ch 4, 5.2 Refrigerant leak detection systems*.

4.7.6 Storage cylinders are to be of an approved type, and are to be filled to a level suitable for an ambient temperature of + 55°C.

4.7.7 The compartment is to be provided with racks to facilitate secure stowage of the cylinders.

4.7.8 The Naval Administration may require protection of flammable gasses from military attack.

■ *Section 5*
Control and monitoring and electrical power arrangements

5.1 General

5.1.1 Control engineering arrangements are to comply with *Vol 2, Pt 9, Ch 7 Control, Alerts and Safety Systems* as applicable.

5.1.2 The equipment used in refrigeration systems is to be provided with local control and monitoring arrangements.

5.1.3 Where isolation of equipment or systems can be carried out, means of indicating the status of isolation is to be provided at positions where the equipment and system can be operated and monitored.

5.1.4 Instrumentation to indicate the operational status of running and any standby equipment is to be provided locally and at any control station.

5.1.5 All pumps are to be provided with an indication of discharge pressure and a low discharge pressure alarm at each control station.

5.1.6 Electrical engineering arrangements are to comply with *Vol 2, Pt 9 Electrotechnical Systems* as applicable.

5.1.7 Refrigeration compressors are to be provided with the following instrumentation and automatic shutdowns:

(a) Indication of suction pressure (saturated temperature), including intermediate stage when applicable.
(b) Indication of discharge pressure (saturated temperature), including intermediate stage when applicable.
(c) Indication of lubricating oil pressure.
(d) Indication of cumulative running hours.
(e) Automatic shutdown in the event of low lubricating oil pressure.

(f) Automatic shutdown in the event of high discharge pressure which is to operate at a pressure in excess of normal operating pressure but not greater than 0,9 of the maximum working pressure.
(g) Automatic shutdown in the event of a low suction pressure.

5.1.8 For refrigeration compressors greater than 25 kW, the following instrumentation, additional to that required by *Vol 2, Pt 11, Ch 2, 4.1 General 5.1.7*, is to be provided:
(a) Indication of lubricating oil temperature.
(b) Indication of cooling water outlet temperature.
(c) Indication of suction and discharge temperatures.

5.1.9 Alarms are to be initiated in the event of the following fault conditions with refrigeration compressors:
(a) High discharge pressure.
(b) Low suction pressure.
(c) Low oil pressure.
(d) High discharge temperature.
(e) High oil temperature.
(f) Motor shutdown.

5.1.10 Refrigeration plants are to be provided with the following alarms:
(a) Failure of condenser cooling water pumps.
(b) High condenser cooling water outlet temperature.
(c) Failure of air cooler fans.
(d) High and low chilled water delivery temperatures.

5.2 Refrigerant leak detection systems

5.2.1 A fixed refrigerant leak detection system is to be provided for any refrigeration machinery containing a mass of refrigerant that exceeds the practical limit for the volume of the compartment.

5.2.2 The leak detection and alarm system is to comply with the requirements of *Vol 2, Pt 6, Ch 1 Control Engineering Systems* and *Vol 2, Pt 9, Ch 11 Gas Detection*. As a minimum requirement, the system is to activate at a low-level concentration to give warning of refrigerant leaks, and at a high-level concentration corresponding to the practical limit for the refrigerant.

■ *Section 6* Testing and Trials

6.1 Testing

6.1.1 The requirements of the Rules relating to testing of pressure vessels, piping and related fittings including hydraulic testing are applicable. *See Vol 2, Pt 8, Ch 2, 10 Hydraulic tests* and *Vol 2, Pt 7, Ch 1, 16 Testing.*

6.1.2 On completion, tanks and reservoirs for service and storage of system fluids are to be tested by a head of water equal to the maximum to which the tanks may be subjected, but not less than 2,5 m above the crown of the tank.

6.1.3 After installation on board, piping systems together with associated fittings that are under internal pressure, are to be subjected to a running test at the intended maximum working pressure.

6.1.4 Testing is to cover the following items:
(a) Verification of control, alarm, and safety systems.
(b) Tests simulating failure of refrigeration equipment to verify correct functioning of alarms and systems in service.
(c) Verification of accuracy, calibration and functioning of temperature control for refrigeration systems.

6.2 Type testing

6.2.1 Evidence that the required performance of refrigeration systems, pump and fan equipment is capable of being maintained under ambient and inclination operating conditions defined in *Vol 2, Pt 1, Ch 3, 4.4 Ambient reference conditions* is to be provided by the manufacturer.

6.3 Trials

6.3.1 Trials are to be carried out to demonstrate that the capability of the refrigeration systems meets the System Design Description. The trials are as far as practicable to be representative of the actual conditions to be encountered in service.

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